

CLAIMS

1. An irrigation system for distributing water to soil, the irrigation system comprising:

a valve coupled to a source of water, the valve having an open position in which water flows through the valve;

a conduit coupled to the valve to receive the water from the valve; and

a sprinkler having an adjustable spray pattern, the sprinkler comprising a housing and a cam, the housing comprising an inlet portion coupled to the conduit to receive the water from the conduit, and an outlet portion comprising a first outlet aperture, wherein the cam is disposed adjacent to the first outlet aperture to control water flow through the first outlet aperture such that water flows beyond a group consisting of the first outlet aperture and the cam along a direction substantially parallel to a cam axis about which the cam is rotatable in-plane, wherein the cam is rotatable to a position in which the sprinkler sprays water about one or more angles totaling more than 270 degrees.

2. The irrigation system of claim 1, wherein the valve is electrically controllable to move the valve between the open position and a closed position in which the valve substantially blocks water flow to the conduit.

3. The irrigation system of claim 1, further comprising a plurality of additional sprinklers and conduits coupled to the valve to receive water from the valve.

4. The irrigation system of claim 3, further comprising a plurality of additional valves, corresponding conduits, and corresponding sprinklers.

1 5. The irrigation system of claim 4, further comprising at least one timer
2 coupled to the valves to control operation of the valves.

3
4 6. The irrigation system of claim 1, wherein the housing comprises a
5 substantially cylindrical shape coaxial with the cam axis, the sprinkler further comprising
6 a casing and a pop-up stem slidably attached to the casing, wherein the housing is
7 attached to the pop-up stem such that the sprinkler operates as a pop-up type sprinkler.

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9 7. The irrigation system of claim 1, wherein the outlet portion comprises a
10 substantially flat wall disposed generally perpendicular to the cam axis, wherein the first
11 outlet aperture is formed in the substantially flat wall.

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13 8. The irrigation system of claim 1, wherein the adjustable spray pattern
14 comprises an arc that is continuously variable through an arc angle, wherein the first
15 outlet aperture extends through the arc angle with respect to the cam axis and has a
16 gradually increasing radius within the arc angle, and wherein the cam comprises an outer
17 edge having a gradually increasing radius within the arc angle.

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19 9. The irrigation system of claim 8, wherein the sprinkler further comprises a
20 deflector positioned such that water exiting the outlet portion through the first outlet
21 aperture is deflected to provide the spray pattern.

1 10. The irrigation system of claim 1, wherein the outlet portion further
2 comprises a second outlet aperture, wherein the first outlet aperture is in fluid
3 communication with a first water distribution feature and the second outlet aperture is in
4 fluid communication with a second water distribution feature, wherein the cam comprises
5 an open portion alignable with either of the first and second outlet apertures to permit
6 water to flow to either of the first and second water distribution features.

1 11. A sprinkler having an adjustable spray pattern, the sprinkler comprising:
2 a housing comprising an inlet portion disposed to receive water and an outlet
3 portion comprising a first outlet aperture; and
4 a cam disposed adjacent to the first outlet aperture to control water flow through
5 the first outlet aperture such that water flows beyond a group consisting of the first outlet
6 aperture and the cam along a direction substantially parallel to a cam axis about which
7 the cam is rotatable in-plane;
8 wherein the cam is rotatable to a position in which the sprinkler sprays water
9 about one or more angles totaling more than 270 degrees.

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11 12. The sprinkler of claim 11, wherein the housing comprises a substantially
12 cylindrical shape coaxial with the cam axis.

13
14 13. The sprinkler of claim 12, further comprising a casing and a pop-up stem,
15 wherein the housing is attached to the pop-up stem such that the sprinkler operates as a
16 pop-up type sprinkler.

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18 14. The sprinkler of claim 11, wherein the outlet portion comprises a
19 substantially flat wall disposed generally perpendicular to the cam axis, wherein the first
20 outlet aperture is formed in the substantially flat wall.

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22 15. The sprinkler of claim 11, wherein the cam is disposed upstream of the
23 first outlet aperture to adjustably impede passage of water into the first outlet aperture.

1 16. The sprinkler of claim 11, wherein the adjustable spray pattern comprises
2 an arc that is continuously variable through an arc angle, wherein the first outlet aperture
3 extends through the arc angle with respect to the cam axis and has a gradually increasing
4 radius within the arc angle.

5
6 17. The sprinkler of claim 16, further comprising a deflector fixedly disposed
7 with respect to the housing and positioned such that water exiting the outlet portion
8 through the first outlet aperture is deflected to provide the spray pattern.

9
10 18. The sprinkler of claim 16, further comprising a deflector rotatable with
11 respect to the housing and positioned such that water exiting the outlet portion through
12 the first outlet aperture is deflected to provide the spray pattern.

13
14 19. The sprinkler of claim 16, wherein the arc includes a spray pattern in
15 which water is sprayed substantially full-circle from the sprinkler.

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17 20. The sprinkler of claim 16, wherein the cam comprises an outer edge
18 having a gradually increasing radius within the arc angle.

1 21. The sprinkler of claim 11, wherein the outlet portion further comprises a
2 second outlet aperture, wherein the first outlet aperture is in fluid communication with a
3 first water distribution feature and the second outlet aperture is in fluid communication
4 with a second water distribution feature, wherein the cam comprises an open portion
5 alignable with either of the first and second outlet apertures to permit water to flow to
6 either of the first and second water distribution features.

7
8 22. The sprinkler of claim 21, wherein at least one of the first and second
9 water distribution features is shaped to distribute water within a shape bounded by a
10 narrow rectangle to facilitate operation of the sprinkler as a strip sprinkler.

11
12 23. The sprinkler of claim 11, further comprising an adjustment dial
13 separately formed from the cam and coupled to the cam to transmit torque manually
14 applied to the adjustment dial by a user to the cam to induce rotation of the cam.

1 24. A sprinkler having an adjustable spray pattern, the sprinkler comprising:
2 a housing comprising an inlet portion disposed to receive water and an outlet
3 portion comprising a substantially flat wall in which a first outlet aperture is formed; and
4 a cam disposed adjacent to the substantially flat wall, wherein the cam is rotatable
5 about a cam axis perpendicular to the substantially flat wall to control water flow through
6 the first outlet aperture;

7 wherein the cam is rotatable to a position in which the sprinkler sprays water
8 about one or more angles totaling more than 270 degrees.

9
10 25. The sprinkler of claim 24, wherein the housing comprises a substantially
11 cylindrical shape coaxial with the cam axis.

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13 26. The sprinkler of claim 24, wherein the adjustable spray pattern comprises
14 an arc that is continuously variable through an arc angle, wherein the first outlet aperture
15 extends through the arc angle with respect to the cam axis and has a gradually increasing
16 radius within the arc angle, wherein the cam comprises an outer edge having a gradually
17 increasing radius within the arc angle.

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19 27. The sprinkler of claim 26, wherein the arc includes a spray pattern in
20 which water is sprayed substantially full-circle from the sprinkler.

1 28. The sprinkler of claim 24, wherein the outlet portion further comprises a
2 second outlet aperture formed in the substantially flat wall, wherein the first outlet
3 aperture is in fluid communication with a first water distribution feature and the second
4 outlet aperture is in fluid communication with a second water distribution feature,
5 wherein the cam comprises an open portion alignable with either of the first and second
6 outlet apertures to permit water to flow to either of the first and second water distribution
7 features.

8
9 29. The sprinkler of claim 24, wherein the cam is disposed upstream of the
10 first outlet aperture so that the cam can block a pathway of water into a variable portion
11 of the first outlet aperture.

12
13 30. The sprinkler of claim 29, further comprising a deflector disposed
14 downstream of the substantially flat wall to deflect water exiting the outlet away from the
15 cam axis.

1 31. A housing for a sprinkler having an adjustable spray pattern, the housing,
2 comprising:

3 an inlet portion disposed to receive water; and
4 an outlet portion disposed to receive the water from the inlet portion, the outlet
5 portion having a first outlet aperture through which the water exits the outlet portion;
6 wherein the first outlet aperture comprises an elongated slot extending through an
7 arc angle with respect to a slot axis and having a gradually increasing radius within the
8 arc angle, with respect to the slot axis.

9
10 32. The housing of claim 31, wherein the housing comprises a substantially
11 cylindrical shape coaxial with the slot axis, wherein the outlet portion comprises a
12 substantially flat wall disposed generally perpendicular to the slot axis, wherein the first
13 outlet aperture is formed in the substantially flat wall.

14
15 33. The housing of claim 31, wherein the arc angle includes a spray pattern in
16 which water is sprayed substantially full-circle from the sprinkler.

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18 34. The housing of claim 33, wherein the outlet portion further comprises a
19 plurality of additional outlet apertures arranged in a spiral pattern with the first outlet
20 aperture.

1 35. A sprinkler having an adjustable spray pattern, the sprinkler comprising:
2 a housing comprising an inlet portion disposed to receive water and an outlet
3 portion comprising a first outlet aperture disposed along a gradually increasing radius
4 extending through an arc angle with respect to a cam axis; and
5 a cam disposed adjacent to the first outlet aperture, wherein the cam is rotatable
6 in-plane about the cam axis to adjust the spray pattern of water that exits the outlet
7 portion through the first outlet aperture.

8
9 36. The sprinkler of claim 35, wherein the cam comprises an outer edge
10 having a gradually increasing radius within the arc angle.

11
12 37. The sprinkler of claim 35, wherein the arc angle includes a spray pattern in
13 which water is sprayed substantially full-circle from the sprinkler.

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15 38. The sprinkler of claim 37, wherein the outlet portion further comprises a
16 plurality of additional outlet apertures arranged in a spiral pattern with the first outlet
17 aperture.

18
19 39. The sprinkler of claim 35, wherein the cam is disposed upstream of the
20 first outlet aperture to adjustably impede passage of water into the first outlet aperture.

21
22 40. The sprinkler of claim 35, wherein the first outlet aperture comprises an
23 elongated slot.

1 41. The sprinkler of claim 35, further comprising a deflector positioned such
2 that water exiting the outlet portion through the first outlet aperture is deflected to
3 provide the spray pattern.

1 42. A sprinkler having an adjustable spray pattern, the sprinkler comprising:
2 a housing comprising an inlet portion disposed to receive water and an outlet
3 portion comprising a first outlet aperture;
4 a cam disposed adjacent to the first outlet aperture to control water flow through
5 the first outlet aperture such that water flows beyond the group consisting of the first
6 outlet aperture and the cam along a direction substantially parallel to a cam axis about
7 which the cam is rotatable in-plane; and
8 a deflector fixedly disposed with respect to the housing and positioned such that
9 water exiting the outlet portion through the first outlet aperture is deflected to provide the
10 spray pattern.

11
12 43. The sprinkler of claim 42, wherein the outlet portion comprises a
13 substantially flat wall disposed generally perpendicular to the cam axis, wherein the first
14 outlet aperture is formed in the substantially flat wall.

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16 44. The sprinkler of claim 42, wherein the adjustable spray pattern comprises
17 an arc that is continuously variable through an arc angle, wherein the first outlet aperture
18 extends through the arc angle with respect to the cam axis and has a gradually increasing
19 radius within the arc angle, wherein the cam comprises an outer edge having a gradually
20 increasing radius within the arc angle.

21
22 45. The sprinkler of claim 44, wherein the arc includes a spray pattern in
23 which water is sprayed substantially full-circle from the sprinkler.

1 46. The sprinkler of claim 42, further comprising an adjustment dial
2 separately formed from the cam and coupled to the cam to transmit torque manually
3 applied to the adjustment dial by a user to the cam to induce rotation of the cam.
4

5 47. The sprinkler of claim 46, wherein the deflector is disposed between the
6 adjustment dial and the cam, the sprinkler further comprising a shaft extending through
7 the deflector, from the adjustment dial to the cam to convey torque from the adjustment
8 dial to the cam.
9

10 48. The sprinkler of claim 47, wherein the shaft is formed separately from the
11 adjustment dial and the cam.
12

13 49. The sprinkler of claim 42, wherein the deflector has a generally conical
14 shape.
15

16 50. The sprinkler of claim 49, wherein the deflector comprises a skirt that
17 extends along a portion of the cam axis to block water flow toward the cam axis
18 downstream of the first outlet aperture.

1 51. A sprinkler having an adjustable spray pattern,
2 a housing having an axis, the housing comprising an inlet portion disposed to
3 receive water and an outlet portion comprising a first outlet aperture;
4 a deflector rotatable with respect to the housing and positioned such that water
5 exiting the outlet portion through the first outlet aperture is deflected to provide the spray
6 pattern; and
7 a cam disposed adjacent to the first outlet aperture, wherein the cam is movable to
8 control water flow through the first outlet aperture, thereby permitting adjustment of the
9 spray pattern;
10 wherein the cam is movable to a position in which the sprinkler sprays water
11 about one or more angles totaling more than 270 degrees.

12
13 52. The sprinkler of claim 51, wherein the adjustable spray pattern comprises
14 an arc that is continuously variable through an arc angle, wherein the first outlet aperture
15 extends through the arc angle with respect to the cam axis and has a gradually increasing
16 radius within the arc angle, wherein the cam comprises an outer edge having a gradually
17 increasing radius within the arc angle.

18
19 53. The sprinkler of claim 52, wherein the arc includes a spray pattern in
20 which water is sprayed substantially full-circle from the sprinkler.

21
22 54. The sprinkler of claim 51, wherein the deflector comprises a generally
23 truncated conical shape.

1 55. The sprinkler of claim 54, wherein the deflector comprises a plurality of
2 vanes shaped to induce rotation of the deflector in response to impingement of water
3 against the deflector.

1 56. A sprinkler having an adjustable spray pattern, the sprinkler comprising:
2 a housing comprising an inlet portion disposed to receive water and an outlet
3 portion comprising a first water distribution feature and a second water distribution
4 feature configured differently from the first water distribution feature; and
5 a cam disposed upstream of the first and second water distribution features, the
6 cam comprising an open portion rotatable about a cam axis to permit water to flow along
7 a substantially straight path through the open portion to reach either of a first outlet
8 aperture and a second outlet aperture of the outlet portion, wherein the first and second
9 outlet apertures are in fluid communication with the first and second water distribution
10 features, respectively.

11
12 57. The sprinkler of claim 56, wherein the outlet portion comprises a
13 substantially flat wall disposed generally perpendicular to the cam axis, wherein the first
14 and second outlet apertures are formed in the substantially flat wall, wherein the
15 substantially straight path is substantially parallel to the cam axis.

16
17 58. The sprinkler of claim 57, wherein at least one of the first and second
18 water distribution features is shaped to distribute water within a shape bounded by a
19 narrow rectangle to facilitate operation of the sprinkler as a strip sprinkler.

20
21 59. The sprinkler of claim 58, wherein the outlet portion further comprises a
22 third water distribution feature, wherein the first, second, and third water distribution
23 features permit adjustment of the spray pattern between center strip irrigation, side strip
24 irrigation, and end strip irrigation.

1 60. The sprinkler of claim 59, wherein the open portion comprises a notch
2 formed in an outer edge of the cam, the cam further comprising a hole displaced from the
3 outer edge, wherein the cam is rotatable into a position in which the first outlet aperture
4 aligns with the notch to provide water flow to the first water distribution feature and the
5 hole aligns with the second outlet aperture to provide water flow to the second water
6 distribution feature such that the first and second water distribution features cooperate to
7 enable the sprinkler to operate as a center strip sprinkler.

1 61. A method for distributing water to soil through the use of a sprinkler
2 comprising a housing and a cam, the housing having an inlet portion and an outlet portion
3 comprising a first outlet aperture, wherein the cam is disposed adjacent to the first outlet
4 aperture, the method comprising:

5 receiving the water in the inlet portion of the housing;

6 moving the water through the first outlet aperture in a manner controlled by the
7 cam such that water flows beyond the group consisting of the first outlet aperture and the
8 cam along a direction substantially parallel to a cam axis about which the cam is
9 rotatable; and

10 distributing the water to the soil about one or more angles totaling more than 270
11 degrees, along a spray pattern defined by motion of the water through the first outlet
12 aperture.

13
14 62. The method of claim 61, wherein the housing comprises a substantially
15 cylindrical shape coaxial with the cam axis, the sprinkler further comprising a casing and
16 a pop-up stem to which the housing is attached, the method further comprising sliding the
17 pop-up stem upward with respect to the casing to elevate the housing upward with respect
18 to the casing.

19
20 63. The method of claim 61, wherein the first outlet aperture is formed in a
21 substantially flat wall disposed generally perpendicular to the cam axis, wherein moving
22 the water through the first outlet aperture comprises moving the water past the
23 substantially flat wall.

1 64. The method of claim 61, wherein the cam is disposed upstream of the first
2 outlet aperture to adjustably impede passage of water into the first outlet aperture, the
3 method further comprising moving the water through an open portion of the cam prior to
4 passage of the water through the first outlet aperture.

5
6 65. The method of claim 61, wherein the adjustable spray pattern comprises
7 an arc that is continuously variable through an arc angle, wherein the first outlet aperture
8 extends through the arc angle with respect to the cam axis and has a gradually increasing
9 radius within the arc angle, wherein the cam comprises an outer edge having a gradually
10 increasing radius within the arc angle, the method further comprising rotating the cam
11 with respect to the first outlet aperture to determine the arc.

12
13 66. The method of claim 65, wherein the sprinkler further comprises a
14 deflector fixedly disposed with respect to the housing, the method further comprising
15 deflecting the water downstream of the first outlet aperture to provide the spray pattern.

16
17 67. The method of claim 65, wherein the sprinkler further comprises a
18 deflector rotatable with respect to the housing, the method further comprising deflecting
19 the water downstream of the first outlet aperture to provide the spray pattern.

20
21 68. The method of claim 65, wherein distributing the water to the soil
22 comprises spraying the water substantially full-circle from the sprinkler.

1 69. The method of claim 61, wherein the outlet portion further comprises a
2 second outlet aperture, wherein the first outlet aperture is in fluid communication with a
3 first water distribution feature and the second outlet aperture is in fluid communication
4 with a second water distribution feature, wherein the cam comprises an open portion, the
5 method further comprising rotating the cam to align the open portion with either of the
6 first and second outlet apertures to permit water to flow to either of the first and second
7 water distribution features.

8
9 70. The method of claim 69, wherein distributing the water to the soil
10 comprises distributing the water within a shape bounded by a narrow rectangle to
11 facilitate operation of the sprinkler as a strip sprinkler.

12
13 71. The method of claim 61, further comprising an adjustment dial separately
14 formed from the cam and coupled to the cam, the method further comprising manually
15 rotating the adjustment dial to induce rotation of the cam, thereby determining the spray
16 pattern.

1 72. A method for manufacturing a sprinkler having an adjustable spray
2 pattern, the method comprising:

3 forming a housing comprising an inlet portion disposed to receive water and an
4 outlet portion comprising a substantially flat wall in which a first outlet aperture is
5 formed;

6 forming a cam; and

7 disposing the cam adjacent to the substantially flat wall such that the cam is
8 rotatable about a cam axis perpendicular to the substantially flat wall to control water
9 flow through the first outlet aperture;

10 wherein the cam is rotatable to a position in which the sprinkler sprays water
11 about one or more angles totaling more than 270 degrees.

12
13 73. The method of claim 72, wherein forming the housing comprises forming
14 a substantially cylindrical shape coaxial with the cam axis.

15
16 74. The method of claim 72, wherein the adjustable spray pattern comprises
17 an arc that is continuously variable through an arc angle, wherein forming the housing
18 comprises forming the first outlet aperture with a gradually increasing radius within the
19 arc angle, wherein forming the cam comprises forming an outer edge of the cam, the
20 outer edge having a gradually increasing radius within the arc angle.

21
22 75. The method of claim 74, wherein the cam is rotatable to a position in
23 which water is sprayed substantially full-circle from the sprinkler.

1 76. The method of claim 72, wherein forming the housing comprises forming
2 a second outlet aperture in the substantially flat wall, forming a water distribution feature
3 in fluid communication with the first outlet aperture, and forming a second water
4 distribution feature in fluid communication with the second outlet aperture, wherein
5 forming the cam comprises forming an open portion in the cam, wherein disposing the
6 cam adjacent to the substantially flat wall comprises disposing the open portion to be
7 alignable with either of the first and second outlet apertures to permit water to flow to
8 either of the first and second water distribution features.

9
10 77. The method of claim 72, wherein disposing the cam adjacent to the
11 substantially flat wall comprises disposing the cam upstream of the first outlet aperture so
12 that the cam can block a pathway of water into a variable portion of the first outlet
13 aperture.

14
15 78. The method of claim 77, further comprising:
16 forming a deflector; and
17 disposing the deflector downstream of the substantially flat wall to deflect water
18 exiting the outlet away from the cam axis.

1 79. A method for adjusting a spray pattern of a sprinkler, the sprinkler
2 comprising an adjustment dial and a housing comprising an inlet portion disposed to
3 receive water and an outlet portion comprising a first outlet aperture, the method
4 comprising:

5 rotating the adjustment dial in-plane; and

6 altering water flow through the first outlet aperture in response to rotation of the
7 adjustment dial to alter the spray pattern;

8 wherein, at one position of the adjustment dial, water is sprayed simultaneously
9 from the sprinkler head in a substantially circular pattern.

10
11 80. The method of claim 79, wherein the sprinkler further comprises a cam
12 disposed adjacent to the first outlet aperture to control water flow through the first outlet
13 aperture, wherein rotating the adjustment dial comprises rotating the cam with respect to
14 the outlet aperture, about a cam axis.

15
16 81. The method of claim 80, wherein the outlet portion of the housing
17 comprises a substantially flat plate in which the first outlet aperture is formed and the
18 cam is disposed upstream of the substantially flat plate, wherein altering water flow
19 through the first outlet aperture comprises using the cam to block a pathway of water into
20 a variable portion of the first outlet aperture.

1 82. The method of claim 81, wherein the spray pattern comprises an arc that is
2 continuously variable through an arc angle, wherein the first outlet aperture extends
3 through the arc angle with respect to the cam axis and has a gradually increasing radius
4 within the arc angle, wherein the cam comprises an outer edge having a gradually
5 increasing radius within the arc angle, wherein altering water flow through the first outlet
6 aperture comprises rotating the cam with respect to the outlet aperture to vary the arc.

7
8 83. The method of claim 82, wherein the sprinkler further comprises a
9 deflector fixedly disposed with respect to the housing, the method further comprising
10 deflecting water exiting the outlet portion through the first outlet aperture to provide the
11 spray pattern.

12
13 84. The method of claim 82, wherein the sprinkler further comprises a
14 deflector rotatable with respect to the housing, the method further comprising:
15 deflecting water exiting the outlet portion through the first outlet aperture to
16 provide the spray pattern; and
17 rotating the deflector in response to contact of the water with the deflector.

1 85. The method of claim 81, wherein the outlet portion further comprises a
2 second outlet aperture, wherein the first outlet aperture is in fluid communication with a
3 first water distribution feature and the second outlet aperture is in fluid communication
4 with a second water distribution feature, wherein the cam comprises an open portion,
5 wherein altering water flow through the first aperture comprises rotating the open portion
6 into alignment with either of the first and second outlet apertures to permit water to flow
7 to either of the first and second water distribution features.

8
9 86. The method of claim 81, wherein the cam is formed separately from the
10 adjustment dial, wherein rotating the adjustment dial comprises transmitting torque from
11 the adjustment dial through a shaft to the cam to induce rotation of the cam.